

DOCUMENT RESUME

ED 287 633

RC 016 357

AUTHOR Canter, Gary
TITLE The Promise of Educational Technology.
INSTITUTION State Univ. of New York, Ithaca. Coll. of Agriculture and Life Sciences at Cornell Univ.
SPONS AGENCY New York State Legislature, Albany.
PUB DATE Sep 86
NOTE 36p.; For other reports in this series, see ED 276 548, ED 281 694, and RC 016 346-358.
PUB TYPE Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Computer Uses in Education; *Educational Policy; *Educational Technology; Elementary Secondary Education; *Expectation; Interactive Video; *Rural Education; Rural Schools; School District Autonomy; Shared Resources and Services; *Small Schools; State School District Relationship; Technology Transfer; Telecommunications

IDENTIFIERS *New York

ABSTRACT

The paper examines the potential which various educational technologies hold for improving educational offerings of small, rural New York schools. Separate sections focus on computer use in education, a review of literature on computer-assisted instruction, interactive videodiscs (IVD), and the role of telecommunications in small/rural districts. Outlined as aspects to examine in evaluating a district's use of computer technology are a written district computing plan, kinds of hardware the districts have, access and equity, usage, staff training, maximization of the technology, and student and teacher attitudes toward technology. Listed as strengths of IVD are constancy and replicability, cost effectiveness, provisions for learner control and choice, and suitability to specific instructional tasks. Mentioned as obstacles to the implementation of school telecommunications systems are high equipment costs; lack of a track record to give a basis for evaluation; need for teacher training; potential for dissension among faculty; imposition of new teaching/learning styles on students; and possible clash of state policies/regulations concerning certification, accreditation, curriculum adoption, and student/teacher ratios. Recommendations made to the New York State Education Department are grouped under categories of excellence, equity, and efficiency. Actions to enhance the infusion of technology into schools are offered to individual school districts and to the New York State Education Department. (NEC)

* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *

ED287633

Department of Education
New York State College of Agriculture & Life Sciences at
Cornell University

The Promise of
Educational Technology

by
Gary Canter

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY

Gary L. Canter

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."

Organizational Alternatives for Small-Rural Schools
In New York State*

Investigators:

David H. Monk
Emil J. Haller
Joe P. Bail

September 1986



*A research project funded by the New York State Legislature (through an appropriation made available to the State Education Department) and the Cornell University Agricultural Experiment Station under provisions of the Hatch Act. The views expressed herein are those of the authors and do not necessarily reflect official positions of the funding sources.

Cornell University is an Equal Opportunity,
Affirmative Action Employer and Educator

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

- ☒ This document has been reproduced as
received from the person or organization
originating it.
☐ Minor changes have been made to improve
reproduction quality.

* Points of view or opinions stated in this docu-
ment do not necessarily represent official
OERI position or policy.

RC016357

THE PROMISE OF EDUCATIONAL TECHNOLOGY

TABLE OF CONTENTS

Introduction.....	1
Computer Use in Education.....	1
How Computers Are Being Used.....	2
What Is the Promise of Educational Computing?.....	3
Criteria to Assess a Rural School District's Use of Computers.....	4
A Review of the Literature on Computer-Assisted Instruction.....	8
Definitions.....	8
Introduction.....	8
Areas of Research.....	9
Research Which Compares Computer-Assisted Instruction With Traditional Classroom Instruction.....	10
Intelligent Videodiscs.....	11
Background.....	11
An Example.....	13
Impediments to IVD.....	14
The Role of Telecommunications in Small/Rural Districts.....	16
Introduction.....	16
The Advocates of Telecommunications.....	18
Telecommunications in New York State.....	20
Telecommunications Projects Around the Country and World.....	22
Problems Associated With Telecommunications.....	24
The State Response to Technology in Education: Recommendation.....	25
Conclusion.....	27
Notes.....	29

THE PROMISE OF EDUCATIONAL TECHNOLOGY

Computer Use in Education

Introduction

The use of interactive technologies in education is at an all time high. A recent survey in Electronic Education (10/85) indicates that 82.2% of elementary schools, 93.1% of junior high schools, and 94.6% of senior high schools use microcomputers. As microchip technology continues to become more sophisticated, prices will continue to go down and computers in the classroom will become even more prevalent. It is highly probable that the ratio of computers to children will drop far lower than the national average of 1 for every 72 students reported in a 12/10/84 New York Times article. In fact, it is not outlandish to envision a fully-equipped school with microcomputers for every pair or quartet of students - or perhaps a machine placed at every desk!

In New York State, survey data gathered by the Information Center on Education's Basic Educational Data System noted a 52.9 percent increase in the number of microcomputers in the total public and non-public K-12 schools between the fall of 1984 and Fall of 1985. More than 84% of these microcomputers were used exclusively for instruction. During this same period the percent of students using microcomputers regularly (defined as direct interaction with a computer as part of a planned sequence of instructional activities) rose from 41.3 to 52.5 percent.¹

The field of telecommunications, or distance learning, has also seen an increase in projects in the last several years. It is estimated that there were twenty-six such projects in various phases during the 1985-86 academic year in New York school districts, BOCES, and post-secondary institutions. Nine of these were operative last year, using either cable, broadcast or telephone based systems to link students at two or more sites to a single instructor. The other seventeen projects are preparing for implementation in the coming school year.

This paper will examine the potential which various educational technologies hold for improving the educational offerings of the small, rural school. In addition to an examination of the impact of microcomputers in the classroom, we will look at the intelligent videodisc system, which is heralded by some as the ultimate teaching machine. Finally we will examine a range of telecommunication projects which appear to offer promise to the geographically isolated, small enrollment school district.

Computer Use in Education

The literature on this subject is replete with predictions and prescriptions for the impact computers will have on the future of education.³ Of particular interest to small and rural schools is the potential of computer technology to help them deal with problems related to size and geographic isolation. Frequently such small districts are unable to offer as wide an array of courses at the secondary level, as well as specialized services at all grade levels. Extremely small enrollment for third and fourth

year language courses, or some of the advanced sciences, may prevent a school from offering such subjects due to the financial burden these underenrolled courses represent. Furthermore, many rural school districts have at times found it difficult to attract teachers with appropriate certification to offer such courses. Into this predicament comes the promise of the computer - offering individualized master instruction to a handful of students on an almost unlimited variety of subjects. Proponents of computers contend that substituting capital expenditures for labor costs will allow a school to increase its academic offerings while at the same time saving money to raise salaries and ease tax burdens. The professional status of teachers will also increase as a result of the integration of computers into the curriculum, as their expertise will become more specialized and thus more valuable to the schools.⁴

Regardless of district size, administrators contemplating the use of educational computing must seek answers to the questions how do computers fit into the educational plan for their district, and what are their goals and intentions for educational computers?

How Computers Are Being Used

There have been many suggested ways to delineate how computers are used in the schools. We identify three broad categories. The first is the use of the computer as a means to teach about computers, a use which is called computer literacy. The Board of Regents of New York has decided that this is a desirable goal for every student in the state, and therefore has included computer literacy training as part of the Regents Action Plan. Included in computer literacy training are topics such as keyboard skills (typing), programming theory, knowledge of how computers work, the various uses of computers, and an awareness of the societal implications and limitations of computers.⁵ School districts across the state have been asked to develop computer curriculums for grades K - 12 to teach computer literacy. Although a 1983 Johns Hopkins study⁶ indicated that two-thirds of all high school student's computing time was spent on computer literacy training, it is probable that such a percentage is considerably lower at this time due to the increase in the second and third types of computer use described below.

Perhaps the best known proponent of teaching programming to school children is Seymour Papert, the inventor of LOGO, a creative programming language for novices which is widely used in elementary levels.⁷ Referring to the computer environment as a "microworld," one where learning is fostered because reality is presented in a "safe" manner, the student may explore and create ideas which contribute to learning. Papert claims that through learning programming skills at an early age, students will create their own software which they will then learn from. Because computers have an ability to simulate situations otherwise unattainable in a classroom, they are particularly well suited for the creation of various microworlds for the learner to interact with. As such they offer endless possibilities for offering challenging learning environments, and when integrated into the curriculum they can actually "teach children to think."⁸

The second category of computer use in the schools is as an aid in the instructional process. This use of the computer as a mechanized instructor is referred to as computer-assisted instruction (CAI) or computer-aided learning (CAL.) There are two prerequisites for the effective use of computers in this role, both of which are major barriers to the widespread realization of the potential offered by CAI. The first is a lack of quality software available in different subject areas (or, perhaps more accurately, the preponderance of poorly done software on the market).⁹ The second is the low level of computer literacy among teachers.¹⁰

The third way computers are used in education is as tools for something else: as calculators, word processors, data-base managers, etc. In this domain computers have been heralded as panacea by some and as an overrated fad by others. Certainly word processing, with its innate advantages over the typewriter in its ability to store drafts of documents for later rewriting and reconfiguration, has been identified as having the potential to revolutionize writing practice and be of extreme benefit to students.¹¹ Data-base programs have already proved extremely effective as an administrative tool for library and central office uses. A familiarity with such programs is seen as heightening students' future professional competence.¹² In this area once again, a limiting factor is the knowledge and ability of teachers to instruct students in the use of such programs.

A visit to any school district will reveal a multitude of ways computers are being used in the classroom. Classifying each instance into one of the above areas helps to study a district's overall utilization of computers, which is a prerequisite to answering the broad question of how to maximize a district's integration of computing technology into the curriculum.

What is the Promise of Educational Computing?

Many educators and technology advocates argue that the promise is very rich indeed, with computers heralding a revolution in education comparable to that of the printing press. Others are just as certain that the "computer revolution" is just the latest in a series of highly touted teaching machines which will follow its predecessors to extinction. In the midst of this debate, those responsible for decision making at a district level need to make decisions now concerning how deeply they should involve themselves with computer technology - what point represents maximum utilization? Small and rural districts with limited resources (both human and financial) are faced with even more difficult decisions concerning investment in computer hardware; often choices must be made between hiring additional teaching personnel versus buying a machine to help do some of the work of a teacher. Stand-alone courses taught entirely by computer promise to be cost-effective - but such courses have not yet been tested and evaluated in vivo, and few districts wish to serve as the guinea pig for untried and untested programs.

Because the field continues to undergo rapid change, it is difficult to discern consensus on the myriad of questions which are raised when one contemplates computer use in the schools. Starting with the more obvious ones such as what types of hardware and software should be bought and how many

computers are enough; one quickly moves on to more complex questions such as how effective is CAI with regards to learning outcome, its effects on students, teachers, and the classroom environment, etc. Without answers to these questions, and without a clear method to incorporate those variables which make every school district's decision-making process, it becomes very difficult to design a sound and meaningful computer curriculum. Yet this is the task confronting school administrators and computer coordinators, for the "computer explosion" is already happening. In the following section a criteria for evaluating a districts' use of computers for educational purposes is presented, with the intention of providing a framework with which to gather data in order to address the above questions. We will then examine what research tells us about the learning outcomes and other dimensions of CAI.

Criteria to Assess a Rural School District's Use of Computers

In order to evaluate the strengths and weaknesses of a district's use of computers, it is helpful to have a vision of what would constitute an ideal utilization of the technology. The following is a description of a hypothetical rural school district making exemplary use of computer technology. It should be understood that few districts are expected to have the wealth and the applicant pool to actually achieve such a program as the one described below. The value of this exercise is for acquiring a measuring stick with which to evaluate current practices.

The wide range of computer options available to school districts as well as the rapid developments in the educational computing and telecommunications fields make the task of describing an "ideal system" a difficult one. We avoid recommending specific brands of hardware and software, for these are most subject to change. The following are general suggestions for district computer usage which tend to be more stable. We contend that the adoption of these suggestions will improve most district's use of computers.

An ideal rural school district's computer program would contain the following:

1. A dynamic and comprehensive educational plan for all students which clearly incorporates the use of computers as a learning tool in appropriate settings across the K - 12 curriculum. Such a plan would be periodically updated and include provisions for (a) the integration of computer assisted instruction with existing curriculum in all subject areas; (b) training in computer literacy (clearly defined) for all students as part of the K-12 curriculum; (c) in-service training in computer literacy for teachers and paraprofessionals. Included should be training in ways to introduce computers into each teacher's particular subject area.

2. Enough compatible microcomputers to allow each student in the district to have access to them throughout the day in every subject area. Classrooms at each grade level should contain sufficient numbers of computers to allow students to work individually or in pairs at a terminal.

3. The capacity to network between computers within the district (student-student, student-teacher, teacher-teacher, student-administrator, teacher-administrator); and to network with outside resources such as regional and national data banks, experts in the field, electronic mail systems, etc.

4. A computer literate teaching staff (including authoring/programming skills), knowledgeable of the uses of CAI in their subject areas. The successful use of computers in the schools depends on the teachers' skills and knowledge of the technology.

5. A software lending library with evaluations of available software in all subject areas that are regularly previewed and upgraded. An ideal system must emphasize the careful previewing and evaluation of educational software prior to selection to determine its appropriateness for use in the classroom.

6. A specially designated computer coordinator to plan, oversee, evaluate and upgrade the district-wide use of the available computer resources on an ongoing basis. The person fulfilling this role will be responsible for ensuring that the district is maximizing its use of computers. Included in this role will be staff training, the acquisition and dissemination of software so that appropriate teachers may preview and evaluate it; and the evaluation of classroom CAI in terms of quality of instruction and learning outcomes. Small school districts may find it impractical to fund a full time position such as this. In such cases the responsibilities should be assumed on a part-time basis by a staff person who has been relieved of some existing duties. These duties should by no means be construed as "add-on" to an already full-time position.

Despite the promise computers hold for education, too often administrators and teachers find themselves the owners of systems which are at best peripheral and superficial to their daily tasks of instruction. There has too often been a lack of planning concerning the integration of computers into the curriculum. A New York State district superintendent who is a member of the Regents Advisory Council for Technology writes that:

Buying computers is one thing, but insuring that they will be accepted and well-used is quite another. What the statistics do not point out is that most schools do not have a well-thought-out plan or rationale for why they are purchasing computers or for how they intend to use them.¹³

In order to evaluate a district's use of computer technology, the following seven areas should be examined. Answers to the questions posed under each area will provide a profile of the district's computing program. The following can be thought of as a "report card" for a district's utilization of computers:

I. District Computing Plan

- a. Is there a written computer curriculum? When was it last updated?
- b. How thoroughly does it address the three areas listed earlier as the first ingredients of an ideal rural school district's computer program?

II. Hardware

- a. What machines does the district have? Are they all compatible, or what percentage of them are?
- b. Does the district provide for networking between computer terminals (i.e., are terminals in the classrooms linked with the central administration, or with terminals in another building)?
- c. Are there linkages with an outside source? (i.e., electronic mail services, a software manufacturer's hotline, etc.)
- d. What is the ratio of number of students to number of classroom computers in the district?

III. Access and Equity

- a. Where are the machines located throughout the district?
- b. Who has access to them, when, and how is access "earned"?
- c. What attempts are made to overcome traditional gender related barriers to computer use? In what ways does the district encourage low income and minority students to make use of computers?

IV. Usage

- a. In what ways do teachers (and staff) make use of the computers? At the secondary level, what are the ratios of courses which use computers for CAI, computer literacy, recordkeeping, and other applications such as word processing? At the elementary level, what percentage of classes use computers for programming, CAI, educational games, etc.?
- b. How do students use computers? By talking with students are different results gotten from above? Is computer use required for certain (non-computer literacy) courses? Are computers used recreationally (when and how often)? Do students in special groups (gifted, special ed, dropout prevention, career education) make specialized use of computers?
- c. In each case where educational software is used, who selected the software and how was it chosen?

- d. Re-figure the overall ratio from 2-d above to reflect the number of students who make use of computers to the number of available classroom computers.

V. Staff Training

- a. Does the district have a computer coordinator? Interview him/her and get a job description. (This is important because there is great variance between districts in the degree of knowledge and the responsibilities of the coordinator).
- b. What training opportunities are offered/available for teachers? Is computer literacy required or urged?
- c. Can teachers request to preview software easily? How often is this done?

VI. Maximization of the Technology

- a. Are teachers encouraged to learn/take advantage of computers and their many uses? For example, are incentives offered for those who take classes at community colleges or other institutions?
- b. Does the district have an active policy (and a proven track record) for reviewing and purchasing new software?
- c. What evidence is there of a district's attempt to expand the number of students and teachers making use of computers?

VII. Attitudes Toward Technology

Interview students and teachers to discern attitudes toward computer technology such as motivation to learn how to use them, sense of their importance to educational and personal goals, and the existence of prejudice and anxieties toward them.

Questions such as the ones above force a district to consider what educational objective will be served by the computer, who will be responsible for it, which students will be served by it, what time commitment and what additional resources will be needed to maximize its use?¹⁴

Through the use of this report card a district can begin to evaluate its own use of computing technology, or gain insight from other districts it chooses to observe and emulate. Hopefully, such careful scrutiny will help to avoid the "buy now, plan later" approach which has become prevalent in education's recent courtship with computers. Too often questions such as these are not asked until it is too late, after purchases have been made and computers are in the classrooms. It must be remembered that unless teachers are convinced of the efficacy of computers in education, no quantity of hardware and software will guarantee successful use of computers. They must be perceived as true partners in the instructional process, which requires a synthesis of course content and technology at all grade levels and in each

subject area. By involving teachers in this process, they will be able to discern which aspects of teaching can be presented more effectively using the computer.

Portions of the challenge may best be met by the Department of Education at the State level, such as the development of a K-12 integrated technology curriculum; and providing a means to disseminate information and solutions to problems which will assist local districts in their adoption of educational technology. Yet it is incumbent upon each district to "look before they leap" to insure the best use of their taxpayers' dollars by carefully considering the uses they plan to make of computers.

A Review of the Literature on Computer-Assisted Instruction

In this review we first define several areas of educational research which are salient to an analysis of the value of computer-assisted instruction (CAI). We then report on a number of studies which have been done in the largest of these areas, that of comparing CAI outcomes with traditional classroom instruction.

Definitions

The following terms appear often in the literature, and may cause confusion unless a standard definition is agreed upon:

The use of the computer to assist or substitute for the teacher by providing tutorial, simulation, drill and practice, educational games, or some other instructive service to learners is known as computer-assisted instruction. Computer-based instruction (CBI) and computer-based teaching (CBT) are also used to describe the same event.

The use of computers to diagnose student performance and prescribe subsequent tasks, as well as to maintain records and assist the teacher in various mechanical duties (recordkeeping, test grading, etc.) is known as computer-managed instruction (CMI).

Introduction

A great deal of research has taken place to attempt to discern the effectiveness of CAI, in the face of the incredibly rapid rate that educational computing has become a part of the academic landscape.¹⁵ There are many questions which this research seeks to answer. Does CAI work? How does it compare with regular classroom instruction, and with other teaching innovations? Is it economically feasible and cost-effective? Does it work better for some purposes than for others? How does it do for different types of learner characteristics? Does it improve intrinsic motivation? What types of learning outcomes are reasonable to expect from CAI - will it teach thinking skills, and thereby improve cognition? These and many more questions

have formed the basis for a variety of sound, experimental research studies in the past several years.

It is interesting to note that research in CAI, and in fact the phenomenon of CAI, is not new, or limited to the past 5 - 10 years. CAI began being studied in the early 1960s in experimental settings - a direct outgrowth of the programmed instruction movement. Early experimenters in CAI included Patrick Suppes, Alfred Bork and Seymour Papert. Government agencies, private enterprise and educational institutions have for two decades provided funding for research in and development of ways to use computers for teaching.¹⁶ Because the technology at the time consisted of teletype terminals and large, expensive mainframe computers, the prospect of CAI being used on a widespread basis was only speculative. With the development of microprocessing in the late 1970s, which allowed transistors to use tiny microchips in place of vacuum tubes, the ability to manufacture large numbers of self-contained, inexpensive microcomputers became a reality.¹⁷

This historical perspective is included to alert the reader that some of the research on CAI - generally that done prior to 1980 - was based on a technology quite different from the microcomputer of today. The effect this may have on our ability to compare these past studies with more recent ones is far from clear. One may assume that computers of the past - far less "friendly" and more intimidating than the desktop models of today - had a different influence on the attitudes and performance of students than do today's microcomputers.

Areas of Research

There are several categories into which research in computer assisted instruction may fall, in an attempt to find answers to the wide array of questions concerning CAI. This review will consider only research which compares CAI with traditional classroom instruction. Other areas in which there have been a considerable amount of research are:

Research on the relationship of learner characteristics to CAI outcomes: These studies examine the question of who learns best using CAI, and why. They tend to be rooted in educational psychology theory, and as such may be conducted under different theoretical paradigms, which makes comparison difficult. Research in this area has implications for the design of computer software, as well as for the design with which CAI is implemented.^{18,19}

Research which compares CAI with programming: Those who advocate teaching programming skills tend to view CAI as limited and traditional in its scope. Claims are made that programming accelerates cognitive development at a greater rate than either traditional classroom instruction or CAI. There is great controversy and little sound empirical evidence in this area. ²⁰

Economic feasibility and cost-effectiveness studies: Research in this category attempts to analyze CAI by comparing its costs with the costs of various other educational delivery systems, and examining the relationship between cost input and learning outcomes. Because measurement of learning

outcomes of CAI in economic terms is imprecise, there is relatively little in the area of cost-benefit studies.^{21,22}

Research Which Compares CAI with Traditional Classroom Instruction

These studies follow classical experimental designs and make use of control groups. Research in this category may be in a variety of cognitive subject areas - mathematics, language skills, sciences, etc. These studies also examine affective outcomes of CAI such as its effect on the intrinsic motivation and attitudes (toward instruction and toward subject matter) of the learner. All ask the same basic question: How does learning done with CAI compare with learning in a regular classroom?

Research in this area has generally supported the efficacy of CAI, particularly for young children. A review of studies which aggregate experiments supports this claim.

Vinsonhaler and Bass²³ reviewed 10 independent studies of CAI and reported results showing a substantial advantage for CAI. Elementary school children who received computer supported drill and practice showed performance gains of from one to eight months over children receiving traditional instruction. This was confirmed in a review by Edwards et al,²⁴ who found that CAI used in conjunction with normal instruction produced better results than conventional instruction alone, and also reduced the time it took students to learn.

Jamison, Suppes and Wells²⁵ found that when computer-based teaching (CBT) was used as a supplement to regular instruction at the elementary level, it improved achievement scores - particularly for disadvantaged students. Their review also disclosed that at secondary and college levels CBT was "at least as effective" as traditional instruction, and sometimes resulted in substantial savings in student time.

A meta-analysis by Hartley²⁶ on experiments on CBT in primary and secondary school mathematics instruction revealed that the average effect of CBT was to raise student achievement .41 standard deviations. This was not as great as the effect attributed to peer and cross-age tutoring, but it exceeded that found as a result of programmed instruction and individual learning packets. Hartley's analysis found that elementary students did better with CBT than did secondary students.

Kulik, Kulik & Cohen²⁷ examined a number of experiments for determining the effectiveness of computer-based teaching at a college level. They found that CBI raised final examination scores by .25 standard deviations, and also had a moderate effect on students' attitudes toward instruction and toward the subject they were studying. Additional meta-analysis by Kulik reported that CBI substantially reduced the amount of time needed for instruction²⁸, and that there is little relationship between design features of experiments (such as duration and year of the study, subject matter studied, etc.) and experimental outcomes²⁹.

In a 1983 study, Kulik³⁰ suggests that CAI may be more effective for younger learners because they tend to benefit more from the stimulation and guidance provided by the highly reactive medium, while older learners (college level) profit from working on their own.

Another meta-analysis was done by Burns and Bozeman³¹ on 40 studies which examined the effects of supplementary CAI in math for K-12 students. Findings suggested that supplementary drill and practice in math was more effective at the elementary level than at the secondary level, but both showed increased performance over groups which did not receive the CAI. These findings also suggest that CAI may be more effective with disadvantaged students than non-disadvantaged students, and with boys more than girls.

Concerning affective outcomes, Hawkins³² reports that there is evidence to suggest that the use of microcomputers in the classroom provides for increased opportunities for interaction and collaboration among students. Condry and Keith³³ cite research which indicates an increase in students' intrinsic motivation as a result of using microcomputers. More recently, Mevarich and Rich³⁴ reported evidence that disadvantaged students using CAI in conjunction with traditional classroom instruction scored higher scores on cognitive and affective measures than students who received only traditional classroom instruction.

One additional study worth mentioning is the Educational Testing Service's evaluation of the IBM "Writing to Read" program, a comprehensive early intervention computer reading program for kindergarten and first graders.³⁵ Results of the evaluation showed that Writing to Read students outperformed comparison students in progress made in reading, and in their writing ability.

We came across one article which made a critical examination of the research on CAI and charged that most of this research is confounded by the novelty effect and/or experimenter bias.³⁶ Additional research is necessary to confirm or disconfirm this accusation.

To summarize, research studies comparing CAI with traditional classroom instruction (TCI) find that when used in conjunction with TCI, CAI provides improved learning outcomes, increased intrinsic motivation, and more rapid learning than TCI without CAI.

Intelligent Videodiscs

Background

The interactive or "intelligent" videodisc (IVD) is a cutting-edge technology that combines the versatile powers of the microcomputer with the quality and quantity of image storage provided by a laser-read videodisc player. The linkage of videodiscs with a microprocessor enables the information on the videodisc to be controlled by the microprocessor so that the system can respond to learner behaviors. Thus the technology offers the interactivity of the computer along with the unprecedented opportunity to

develop new ways of representing information, including multimedia schemes that would mix different representational forms in whatever ways are most conducive to learning.

Proponents herald the intelligent videodisc as the wave of the future for educational technology.³⁷ Its characteristics which make it such a potentially powerful tool include (a) efficient storage and retrieval of great amounts of a variety of information - video images, audio sequences, animation, graphics, etc; (b) large degree of learner control (interactivity) which comes from combining the powers of a computer with the rapid response time of the videodisc; and (c) adaptability in the way it presents instruction to individual differences in the learner.

The components which comprise an IVD system are a microcomputer and a laser videodisc player. There are about 14 varieties of videodisc players on the market, but not all of them are adaptable to computer control. To link the two a microcomputer videodisc player interface is required. This unit translates output from the computer into input commands which control the disc player. (Cost ranges from \$300 to several thousand, with a median price of about \$500.)

Finally the system requires an authoring system, which is microcomputer software that uses high-level language to convert user commands into machine language commands for controlling the disc player after prompting the user to provide the necessary information. This is how the user at the computer terminal can "program" the vast array of material stored on the videodisc in any number of ways with no computer programming experience.

One disc can store about 30 minutes of moving images, or 54,000 still frames per side. Laser use makes for very quick retrieval, within about three seconds or less. The discs are very durable - the quality of the image is not subject to the deterioration of film, tapes or slides. The price of one videodisc ranges from \$20 - 35.

The prototype of the videodisc was developed in 1927, when John L. Baird developed a technique for storing television images on phonograph records. In the 1930s prerecorded "Phonovision" discs were available in department stores in London, but the innovation never thrived, probably due to the primitive state of television at the time. The technique for recording television images on disc lay dormant until the 1970s. At that time RCA revived it, with a system which used a stylus which rides over a grooved and pitted surface. Most of the current models such as Sony and Pioneer use an optical scan process which involves a laser.

In the early '80s there was a big market predicted for videodiscs, particularly with respect to the entertainment field. These discs were non-interactive, or linear discs - capable of displaying their contents only in sequential order much like an audio recording or videotape. Although this potential has not been fully realized, videodiscs are mass produced and available on the market at a reasonable cost (approximately \$20.) There has been wide use of the non-interactive videodisc in industry and the military, largely because it is seen as a cost-effective, labor-saving training device.

The advent of interactive videodiscs often seems to be just around the corner. Yet despite their many desirable features, development of the system and its implementation in primary, secondary and higher education has been virtually nonexistent. The National Science Foundation funded a project in the development of discs, but it dried up when federal funds were withdrawn. A collaboration between the ABC television network and the National Education Association to produce The ABC NEA School disc - a series of interactive magazine-type discs which would be issued yearly - was abandoned because it became too expensive to program.

A study on the feasibility of IVD in public education done by the Alaska Innovative Technology Project for the Office of Technology and Telecommunications of the Alaska Department of Education advised caution in pursuing the technology.³⁸

With all its promise, why hasn't IVD had the impact on education predicted for it? Perhaps an illustration of an IVD lesson will help explain.

An Example

First, imagine a traditional high school biology lab in which students are required to dissect a frog. Prior to the lab, they have used a number of instructional methods to prepare for it. They have read text and viewed photographs and charts of the frog physiology in their lab book. They have been lectured by an instructor, and perhaps been treated to various chalkboard displays. They may have seen a film or slideshow of a dissection.

In the lab, students work in pairs or foursomes over a preserved frog in a dissection pan, with an assortment of knives and pins to incise, probe, pinch and cut. They carefully follow a linear procedure which has been outlined for them in their lab manual, which lies spread before them like a recipe. The teacher roams the aisles of the lab offering suggestions and probes, and answering those questions which are raised and communicated.

Now imagine the same pair or quartet of students seated in front of a microcomputer with a video screen display unit. On this display they view a variety of information pertaining to frogs, which they select from a menu. They look first at various photographs of the frog, then at a 15-second sequence of a frog swimming underwater and emerging for air and to capture a fly (this last in super slow motion to capture the unfurling of the tongue). Then in succession they peer at labelled drawings of a frog's external and skeletal structure, for as long or short as they wish. Overall there are dozens of frog-related pictures, drawings and animated sequences available for viewing. When they type in the command for questions, the screen poses several conceptual ones which they will attempt to answer during the dissection:

What physical properties does the frog have which serve it well in its attempts to secure food and avoid predators?

How does the frog manage to spend so long a period underwater while still breathing air through its lungs?

When the students have adequately reviewed the material on the frog and received their questions, they are ready to proceed with the lab. A typed command yields an overhead view of a frog spread-eagle on its back in a dissection tray, appendages pinned in the four corners. To the side of the tray lay various instruments. The students are able, through one of a variety of means such as the keyboard, joystick or mouse, to tell the computer what to do first. When they order a horizontal incision across the abdomen, they instantaneously see such an incision being made. Now they ask that the skin be peeled back and clamped to reveal the frog's insides. They realize they've made a mistake, the incision should have been vertical. A typed command issues forth a new frog, and the correct incision is made.

For the next half hour the students experiment with opening and closing various parts of the frog's anatomy. They manipulate organs to study their placement in the frog's body, and they examine each one in detail after removing it surgically. They ask questions directly by typing them into the computer, such as "why are the frog's lungs so feathery," and the monitor responds with information about the lung. When they wish elaboration of some aspect of the frog, they use the help command to ask for additional information. If they request information on the frog's heart, for instance, they may be shown a short video of the parts and functions of the frog's circulatory system.

This example is meant to illustrate both costs and benefits of this technology. The uses such a device could be put to, and the options which could be programmed into learning exercises such as this lab, are limited by only imagination, creativity, and the cost for producing such a sequence. Yet there lies the rub: to produce the software described above would cost literally hundreds of thousands of dollars.

Impediments to IVD

Of the varieties of interactive automated teaching tools extant today, IVD represents the ultimate in state of the art technology. Yet it's proliferation in the schools has not been forthcoming - we are not aware of a regular curricular component using IVD in New York State. Besides the general problems of startup and implementation shared by computer technology (such as the lack of quality software, a shortage of educators trained in the use of the device, teacher reluctance to become facile in their use, cost restrictions, the reluctance of school districts to view the technology as a labor-saving means, and a lack of a universally accepted method for integrating the technology into the curriculum), IVD brings with it a unique problem in the extremely high cost of development for the educational programs. The production costs required to design, program, produce and enact an interactive videodisc appear to begin at nearly \$100,000 for even a basic, limited-interaction program. According to one expert:

It simply is not feasible to market adaptive, interactive, computer-controlled videodisc courseware that even begins to tap the potential of the medium or cover the curriculum of schools, businesses, or the military. Pilot projects will continue to produce exciting and effective prototypes, but the widespread dissemination of the technology is likely to be compromised by its own potential and the economic constraints of the educational marketplace.³⁹

One solution to this problem is in providing generic discs which local educators can program themselves. Instead of the linear discs which recording and broadcast industries mass produce cheaply, a generic disc would contain a variety of standard sequences that reflect the variety of the subject matter from "all angles." Since such discs might have a wide appeal, they could be mass produced inexpensively, and local educators could program them by means of the computer authoring system.

Another barrier to the widespread acceptance of IVD concerns the ability of an interactive system to respond to individual learning differences. The study of this subject is known as aptitude-treatment interaction, and research in the area is decidedly inconclusive as it suggests the incredible complexity in the relationship between teaching mode and learning style. It is thus important to view critically the claim that IVD allows for the accommodation of great variation in learner styles.

To summarize, there are several considerations to "slow the bandwagon" of IVD, including:

a.) It is expensive due to extremely high production costs. Software for the fully interactive discs is not yet developed to any large degree.

b.) The existence of quality IVD will not necessarily revolutionize education unless teachers know how to use it and are willing to use it. Quality films and video have not revolutionized education despite their existence.

c.) One needs to be wary of the term interactive. A technological system called interactive isn't necessarily better than a well-organized book with a good index and table of contents. In some computer and videodisc programs the interactivity is sophomoric and insulting.

d.) One also needs to be wary of the notion of active learning. The act of pushing a button or doing some such motor response doesn't make for quality learning. The need for involvement must be germane and not contrived. Similarly, high quality, interactive learning can occur without physical activity on the part of the learner (say watching a good movie, or listening to a fine piece of music.)

e.) Unnecessary visual information can be a distraction.

f.) Educational use of IVD should not be based merely on its high quality and the great capacity for visual storage. To merely reproduce books and other visual items would be a misuse of the system. Like computer technology, this innovation must be carefully integrated into the academic curriculum.

The strengths of IVD which give it its potential include the following:

a.) IVD are constant and replicable. When it is important to transmit an instructional message consistently, IVD is useful. It is not subject to human error in the transmission of material.

b.) When an instructional module will be used repeatedly, the cost of the instruction can be reduced by using an automated system. Thus the more universal the teaching is to be, IVD becomes more cost effective.

c.) IVD systems can provide for individual differences among learners by providing interactivity if learning sequences can be developed which are truly multi-branched and allow the learner to exercise control and choice. With such a system the use of IVD could provide quality instruction more efficiently and effectively than through the traditional classroom method.

d.) There are certain kinds of instructional tasks for which video information is very useful. For example, a unit on blood circulation would be improved by the use of animation, freeze frame, slow motion, and ability to repeat the sequence.

e.) A record can be kept of the progress of the learner, recording the stages and options s/he took through a sequence.

The Role of Telecommunications in Small/Rural Districts

Introduction

Much has been said of the promise which educational technology offers the small school in dealing with problems related to size such as geographic isolation, small class size, and limited ability to attract talented teaching and administrative applicants for positions. Many small school districts additionally suffer from a limited economic base which places strain upon their ability to provide a quality learning program. In the face of such difficulties, pressures to increase in size and economic base via school district reorganization is great. However, both because of the sense of tradition fostered within small schools, and the deeply held beliefs in the benefits which accrue from smallness, many districts reject reorganization. In such cases the attractiveness of telecommunications or distance education, coupled with the on-site use of computer technologies such as CAI, is heralded as a possible answer. In the following pages we will examine the promise which telecommunications offers the rural school district.

Because of the recent and ongoing development and refinement of educational telecommunications systems, most evaluations of school projects

which utilize such systems are ongoing. It is very rare to find summative results of distance learning. The handful of evaluations which we have come across are formative in nature. Therefore, it is difficult to conclusively discern what works based on the literature on distance learning, as a great percentage of that literature is speculative.

Education has long made use of audio-visual teaching aides: slide shows, filmstrips, and educational television have been a classroom presence since the 1950s. In the past ten years the growth of cable television and the development of the videocassette recorder has had a huge effect on educational media. Teachers may now record programs from the major networks or from local access public television and use them in their classes at their convenience. Educational materials are now available to the schools on videocassettes on an extensive array of subjects.

In the past five years innovation and refinement within the telecommunications industry has created a number of interactive systems available to the schools at a reasonable cost. Procedures which only recently were conjecture in futurist literature and in science fiction are now being heralded as the educational delivery system of the eighties. Some point to the fervor raised over programmed instruction and the teaching machines and materials of thirty years ago, and confidently assert that this too shall pass, the educational establishment has been warned of a "revolution" in its methods before. Yet when one considers the powerful abilities of the microcomputer which make it far superior to its Skinnerian predecessors; and adds to this the ability to teach and learn over long distances using a two-way interactive visual medium wherein the learner responds to and receives feedback from the teaching source, the prospect of a radical change in education seems plausible.

This discussion will focus on the various applications of telecommunications in the schools, particularly with regard to rural schools and their unique needs. The following are the major categories of technologies currently used or slated for instructional and cultural use in rural New York.⁴⁰

Two-way interactive television (TWIT) uses terrestrial microwave, cable or fibreoptics to transmit visual and audio signals between transmission and receiving points. In a fully equipped system (one where each point can receive and transmit), each point contains a video monitor and speakers to hear and see incoming messages or lessons, as well as a microphone and video camera to send signals from the studio. These systems usually involve a course which is taught from one classroom/studio equipped with multiple monitors to receive images and sound from the classrooms to which the lesson is being broadcast. One of the case studies for this research was conducted in a New York district which was making experimental use of this technology. See Bilow (1986) for details. The teacher can see the class or classes to which s/he is broadcasting upon these monitors, and they can in turn see the teacher on their monitor. There is usually a "live" class at the origination point, although this is not always the case.

Variations on TWIT are two-way interactive audio-only systems; and two-way audio, one way video (as in the Tompkins County BOCES course described below whereby the teacher was broadcast via television cable into the receiving classroom, and could talk with the students over phone lines). It is less expensive to provide only the audio component of the transmission, which can be done over phone lines. The video portion requires cameras and monitors at each transmission point. Audio-only systems are more difficult to use, particularly when there are a large number of participants' voices coming over the lines.

Instructional television fixed services, or narrowcasting, involves the one-way only audio and visual transmission from an origination point to one or several receiving points. This technique is not different from educational television except that the broadcast can be inexpensively done and is made only to the intended recipient point(s).

The electronic blackboard, often coupled with a two-way audio transmission, allows text and graphics written on a special chalkboard to be received and displayed on a television monitor at one or more points. As letters, numbers and figures are entered onto the blackboard, they are immediately translated into telephone signals that are communicated using the existing phone network to boards at another site or sites.

The introduction of fibreoptic cable to telecommunications represents a significant benefit to the cost and efficiency of long distance transmissions, as it carries a much larger volume of communications in the same space as its metallic predecessors. However, in all such cases one still needs to be physically connected to each receiver and origination site.

Other systems free the users from being physically connected. These include radio, microwave and satellite transmissions. Sideband capabilities, or subsidiary communications authorization, involves using empty frequencies which accompany every FM radio station main carrier. Like radio sideband, satellite technology is a point to multipoint distribution system which is good for one-way only transmission.

The Advocates of Telecommunications

Given the variety of telecommunication systems, there are strong arguments made for their use and their value to rural schools. Noting the increased course requirements of the Regents Action Plan, one newspaper reporter noted that: "If many students are going to get the courses they need, they are going to have to get them by long distance."⁴¹

In their book entitled *Modernizing the Little Red Schoolhouse*, Willet, et al (1979)⁴² contend that: "Given the technology now available, there are too many people employed in elementary and secondary education, and they are improperly deployed" (pg. 7). They suggest that the educational process is woefully inefficient: nationally about 83% of the instructional budgets of elementary and secondary schools go to salaries of instructional staff.

Education is currently a labor-intensive endeavor - the authors suggest using technology to adopt a capital-intensive method.

Loughary, et al⁴³ proposed making greater use of "man-machine systems". These are a set of "planned procedures in which man and machine capabilities are used in an integrated manner to achieve results man could not achieve without the machine" (p. 5). His suggestion was made in 1966 and included the mainframe computers of his day and the early versions of cable television.

Willet and his colleagues emphasized that expanded use of technology in education will result in benefits to students and parents. The use of such a system would provide

A more stimulating and hopefully a better formal learning experience. The experience would be personalized for each child, reducing the frustration and boredom which characterizes today's schools. The time in actual learning, which seems to be the strongest school factor correlated with cognitive achievement, would be increased, while time in school may decrease.⁴⁴

Standing in the way of adopting systems such as these, however, is an anti-technological attitude held by a large segment of current society. This reluctance to change is due in part to the lack of widespread understanding of the present feasibility of capital-intensive education, as well as the entrenched bureaucracy of the educational establishment. Add to this an oversupply of teachers and there seems little probability that moving to man-machine systems of education will be warmly received.

Nevertheless, Willett contends that by moving to capital-intensive arrangements which are now possible, distinct advantages such as savings in yearly per pupil expenditures would accrue which would literally pay for the new system of technology; a slowdown in the steady increase in the cost of education; and an increase in the professionalization of educators through greater specialization.

If education as a good or service were produced entirely in the private sector of the economy under relatively competitive conditions, rational decision-making today would mandate capital-intensive methods to better allocate scarce resources.⁴⁵

The authors issue the following challenge to educators and policy makers:

Investment in people is also what this book is about. The process of education as it is now carried on is extremely wasteful of human resources, both of those who attempt to educate, and of those who attempt to learn, in relation to energy and time. Systematic, planned incorporation of

the technologically advanced real capital, now available, into the production of education is not being done. Until this is done, the gains from an increased knowledge base, and from increased education per worker, cannot contribute to greater improvement in the effectiveness of the nation's education delivery system.⁴⁶

Telecommunications in New York State

In light of the Board of Regents' Action Plan to Improve Elementary and Secondary Education Results in New York, many small and rural schools are looking with interest at the prospect of telecommunications. Providing learning opportunities equitably to the homebound, the economically disadvantaged, the disabled and the handicapped student has become an even greater challenge to the small school. Declining enrollments also signal financial stress upon a district's tax base, and schools experiencing such trends are particularly hopeful that technology might assist them in providing quality educational programs. The following distance education programs have been pioneered recently in the state and offer promise to districts seeking alternatives.⁴⁷

In Westchester County eight school districts have a common cable television system and are studying the feasibility of using this system to offer courses which are not available to some of the school districts. Equipping classrooms at Pleasantville, Ossining and Tarrytown High Schools with monitors, cameras and microphones, two interactive classes were taught in 1985. A pilot ecology program was conducted in the spring between Pleasantville and Tarrytown. A Latin class was broadcast to Ossining High School from Pleasantville in the fall of that year. Finally, a series of teleconferences between the Boards of Education of Ossining and Pleasantville are broadcast to the community over the public cable. Informal evaluations of the courses deem them successful.

In the St. Lawrence-Lewis Counties BOCES district, the high school in Gouverneur district is linked with two others (Edwards and Harrisville) via a microwave broadcast two-way interactive audio and video system which allows for courses to be taught at any of the three schools to classes at the other two. One teacher can monitor activities in three classrooms and converse with every student. Classes offered in 1985 included shorthand, psychology, business, Latin and english.

The Delaware-Chenango-Madison-Otsego BOCES has piloted two telecommunications courses using AT&T Communications, Inc. telephone bridge system. This system utilizes telephones, computers and electronic blackboards to enable the transmission of voice, graphics and data. In 1985 an astronomy course was offered in the spring, and an advanced-placement calculus class was offered in the fall.

Two upstate central school districts are collaborating with SUNY Brockport via an electronic blackboard/audio system to offer high school seniors at Perry and Warsaw Central Schools advanced courses in calculus and

economics. Students receive actual college credit for these courses taught collaboratively by the two local teachers and an instructor from SUNY Brockport.

A collaboration between the Ithaca College Departments of English and Communication Arts, the Tompkins County BOCES, and the Newfield School District resulted in an advanced placement English Literature course being offered to a group of Newfield High School students in 1985/86.⁴⁸ A three million dollar federal grant was received to pilot projects of this sort, in which an Ithaca College English professor taught courses in the studio which were broadcast over public access television station Channel 13. Students at Newfield High School received the video and were linked to the teacher in the studio via two way phone lines.

The instructor indicated that the class was both demanding and fun for her, causing her to spend a great deal of time preparing each lesson to compensate for not having direct visual contact with the learners. She also indicated a certain amount of pressure because the lessons were broadcast for anyone with a television to receive. Technical difficulties were frequent, however - there were many times when auditory signals were down and she could not communicate with her class.

Results of the national ETS exam (available in July) will be one measure of the project's success. Students who pass this exam may qualify (according to the individual policies of the colleges they attend) to be exempted from one semester of their freshman english requirement. However, regardless of the outcome of the exam, the objective of utilizing distance learning to provide a course experience to students in a rural school who would otherwise not be able to experience such a course has been met. Another measure of the project's popularity is that in 1986/87 a second school has agreed to participate in the AP English course.

There are several more projects throughout the state which have not been mentioned here, and over a dozen more in the planning stages.⁴⁹ A coordinated evaluation of these projects would be greatly beneficial to those districts now considering their future participation in telecommunication projects. Centralized dissemination of information gleaned from these evaluations would be extremely helpful to these districts, as well as setting the stage for a statewide telecommunications system which would avoid redundancy and take full advantage of networks already in place. The importance of the State Education Department's leadership and dissemination of information is emphasized by Gregory Benson, Director of the Center for Learning Technology:

The potential for extending and merging resources from a variety of educational and cultural programs to focus on critical needs in elementary and secondary education is great. The capacity of a well planned telecommunications system that takes into account various extant capacities and growing applications can move educators in New York State toward a rational approach to meet that challenge.⁵⁰

The post secondary education system in N.Y.S. is already greatly dependent upon telecommunications for administrative purposes among the 64 SUNY campuses and community colleges. In 1985 the State Education Department proposed the creation of a "SUNYNET" system to serve and coordinate the vast array of post-secondary telecommunications applications among the SUNY campuses. This system holds great potential for improving telecommunications in the elementary and secondary schools, because of their proximity to many of the SUNY campuses and the resources contained within the colleges which could be made available to the public schools.

Telecommunication Projects Around the Country and the World

Perhaps the ultimate telecommunications project has been realized at tiny Hall High school in Northern Illinois, which is part of a 500 student school district.⁵¹ In 1981 members of the science club, with help from vocational education students, constructed a homemade satellite system on which they intercepted satellite pictures of Saturn transmitted from Voyager II. The system was constructed using two radar sets and four dishes bought from the Federal surplus Agency for \$100, along with a total of \$1,500 in electronic equipment and additional donated materials. A boat winch and a garage door spring are used to tune the radar dish to the proper satellite frequency.

As a result of their surprising reception of the Voyager II Saturn photos, Hall High School and NASA organized a cooperative venture whereby the school works as a clearinghouse for other schools across the nation in disseminating information from NASA and promoting direct satellite transmissions. "Classroom Earth" is the name of this organization, which was to have been the primary receiver of the lesson from space this past February which teacher/astronaut Christa McAuliffe was to have broadcast on the ill-fated Challenger mission.

The ability to receive transmissions from five different American and three Canadian satellites enables the school to use their telecommunications project in the classrooms in a variety of ways, from improving foreign language skills by watching educational broadcasts in French and Spanish, to making use of public domain programs obtained from domestic communication satellites as supplementary classroom teaching materials. Superintendent Walt Westrum notes:

From this teachers have found that students are increasingly interested, motivated, and better informed about the background of events, processes and cultures. . . (W)ith the aid of the satellite television system, videocassette recorders and classroom television, teachers have been able to 'bring the world' into their classrooms.⁵²

Australia makes widespread use of distance education due to its large number of isolated schools.⁵³ The Australian domestic satellite AUSSAT, launched in the fall of 1985, was intended to facilitate effective distance

learning. To date, however, it has been too expensive for the schools to use and serves only industry. In preparation for the time when the satellite will become available to them, classrooms in rural schools have been equipped with telephone lines networking them to other schools and universities to provide a simulated distance learning situation. In the absence of the satellite component, these simulations have proven very effective.

Initially the simulations used existing telephone lines to give principals of isolated secondary schools access to inservice training for their staff, teletutorials for students engaged in homebased university studies, and an outreach program for isolated and disabled students and aborigines. By 1986 over 65 South Australian schools had installed inexpensive audio teleconferencing terminals known as DUCT terminals, which can be operated over a single phone line.

One special application of distance learning was implemented by the Educational Technology Centre (ETC) in Adelaide, South Australia. They conducted a multi-media experiment whereby supplementary classes were provided to all fifty students at the Tarcoola Special Rural School, located 500 miles away in the state's remote northwest. Instruction was provided using the telephone link and equipment such as loudspeaking telephones, slow scan TV and videotex. An independent assessment of the project showed favorable results, with students accepting the new technology and learning from it.

Oklahoma State University in Stillwater offers an "Arts and Sciences Teleconference Series" for public schools. It uses a satellite to transmit courses to places such as Leedey, Oklahoma, a district of 200 students with 46 high schoolers. Twenty-one school districts in Oklahoma, New Mexico, Arkansas and Colorado receive these interactive classes which include a limited range TV transmission called "instructional TV fixed service". The system uses the satellite for a visual component, telephone for the audio, and computers and electronic blackboards for graphics and data.

Texas Education Department oversees distance learning through the "Texas Interactive Instructional Network" (which is satellite relayed video and telephone audio), and "Interactive Instructional Television Network" (microwave and telephone). They are relying increasingly on distance learning due to a severe shortage of teachers, particularly in rural areas, and an increase in graduation requirements in 1984 from 18 to 21 credits.

The Utah State Office of Education uses distance learning to "overcome (the) imbalance in course offerings between rural and urban districts..."⁵⁴

Mexican Telesecundaria is an ITV system which makes secondary school possible in towns where there is none. Students in the program perform as well on achievement tests as students in the same grades in Mexico City.⁵⁵

Problems Associated with Telecommunications

Because an instructional system is called interactive does not mean that it provides a higher level of interactivity than does a well-organized book on the same topic with a good table of contents and index.⁵⁶

A brief list of obstacles to the implementation of telecommunications systems in the schools includes:

(a) High equipment costs. Although in the long run distance learning may save money by eliminating excess labor costs, it requires an initial large capital investment which frightens many potential districts.

(b) Because the advent of these systems are so recent, there is little to evaluate, which makes the claims of the skeptics difficult to refute. Jamison wrote in 1978: "The larger and more expensive these (new technology) systems, the more they challenge administrators and planners to face up to questions of cost effectiveness."⁵⁷

(c) Teachers need additional training. Both the operation of the equipment, and the act of teaching require training and practice. Many teachers feel uncomfortable talking to a camera to reach a distant audience.

(d) Despite proponents' claims to the contrary, most of these systems represent a somewhat "fragile" technology. The Gouveneur TWIT project experienced a great deal of down time in its first year of operation, as did the Tompkins County BOCES cable project. Any teacher who has been disappointed by a film projector or video recorder will be wary of the potential for glitches in a complicated telecommunications system.

(e) Telecommunications may create disharmony in the faculty, creating an imbalance in prestige and perhaps compensation between those who teach courses over it and those who don't. A potential exists for dissension among the staff. For more on this point see Bilow's case study (1986).

(f) The technology represents an imposition of new teaching and learning styles on students. While this should not in itself cause a district to eschew change, it must be considered in light of the trial nature of the new technology and the uncertain outcomes of these early experiments. The students' time in high school is not a trial period, nor are they willing guinea pigs.

(g) There is a possible clash of state policies and regulations in the following circumstances: when learning crosses state lines; when certification questions arise; determining course accreditation; deciding on curriculum adoption between schools; and the effect it has on student/teacher ratios.

A report made to the Regents of May, 1985 which contained action recommendations also identified institutional and societal barriers to excellence including inadequate staff development, lack of quality software, and skepticism about long-term effects and institutional barriers.

The rapid evolution of telecommunications systems, the continual deregulation of rates and laws, and the existence of "untapped" capacities require that greater attention be given to planning a comprehensive telecommunications system to support the educational and cultural enterprise.
58

The State Response to Technology in Education: Recommendations

The State Department of Education has displayed a serious interest in the statewide development of educational technology and telecommunications resources. Gregory Benson, Director of the Education Department's Center for Learning Technology, writes:

. . . (T)he educational needs of N.Y.S. must be addressed immediately since telecommunications provides enhanced learning opportunities at significant cost reductions. . . The growing role of information as a commodity and crucial resource for economic development, the need to provide greater access to learning opportunities at all levels in response to enhanced academic requirements and retraining needs, and the need to provide rural areas and special populations with equitable educational and cultural opportunities are all placing severe stress on current delivery systems. (*italics added*)59

In May 1985, the Regents approved a set of fifteen action recommendations related to the enhanced use of learning technologies and telecommunications in New York State. The computer, the interactive videodisc, and broadcast telecommunications technologies were identified as the important resource areas for strengthening educational programs and services. These recommendations identified three major goals of the Department: excellence of instructional programs, equitable access to the benefits technology affords, and efficient technological applications. The recommendations were derived from the following key technology issues:

Research and development activities must address the application of the technologies to meet the needs of education, the dissemination of information concerning technology to persons in the field, and the need to conduct systematic evaluations of interactive technologies to ensure appropriateness and effectiveness.

Professional development is needed to guarantee that the learning technologies and telecommunication systems will be appropriately integrated within the schools. Adequate provision of effective preservice and inservice training is called for.

The presence of high quality instructional materials is seen as a key to the success of any educational program utilizing technology. There is evidence to suggest that the quality of current materials is inadequate (see the preceding section on computer use in education).

Telecommunications (electronic networks) have the potential to help the state achieve the goals of equitable and enhanced delivery of educational services with increased efficiency and cost-effectiveness.

Technological integration into the content and program areas of the educational institutions is necessary for effective use. Additionally, the technologies themselves should be integrated to capitalize their collective strength.

The following are the action recommendations made to the SED, grouped according to each major goal:

Excellence

#1. Create a learning technologies and telecommunications research and development agenda.

#2. Conduct "producer/consumer" forums to enhance the quality of materials and systems produced for education, and to ensure a match between educators and educational material developers.

#3. Encourage the review of certification programs in appropriate department offices to assure that minimal competencies and knowledge about the uses of the learning technologies are included in certification requirements.

#4. Conduct model staff development programs to train a variety of educational professionals in learning technology.

#5. Develop and strengthen alliances with national, state and regional organizations to share information about high quality learning technology opportunities and resources.

Equity

#6. Focus learning technology and telecommunications efforts on institutions most in need with regards to achievement and competency test scores and dropout rates.

#7. Work with hardware and software producers to address the development and introduction of computer peripherals and software for the physically handicapped and learning disabled, so that they may gain access to and effectively use learning technologies.

#8. Develop appropriate staff development programs designed to end stereotyping and sex biases in curriculum-oriented programs. Replicate such training models to institutions serving low wealth and minority populations.

#9. Conduct survey research and implement an annual data collection procedure to closely monitor the efforts to achieve a more equitable distribution of learning technology and telecommunications capacity.

#10. Arrange statewide volume price discounts for hardware and software to ensure that there is greater access to technologies.

#11. Recommend legislation in 1986-87 which addresses enhanced access to technology and assists low wealth and minority School districts to apply technology.

Efficiency

#12. Identify exemplary programs and transfer them from other sectors (military, industry) to the educational realm.

#13. Propose legislation and regulations such as tax incentives and copyright protection to encourage private sector investment in learning technology products.

#14. Seek legislative support to provide financial incentives to enable educators to take advanced training and pursue project development activities in the area of educational technology.

#15. Conduct a comprehensive study concerning the implementation of a statewide telecommunications network which might be used by all State agencies, thus avoiding duplication and increasing efficiency.

As a followup to the approval of these recommendation, the Commissioner of Education also created the Education Department's Learning Technology and Telecommunications Task Force, issuing it the charge to assess the technology initiatives presently extant in the Department, and to seek ways to better integrate existing and new technology initiatives. Together with the Regents Advisory Council on Learning Technologies, these complementary bodies have made policy recommendations in the areas of cooperative service aid, teacher preparation, distance learning, non-public school instruction, and public/private relationships.⁶⁰ In May, 1986 the Advisory Council published an extensive update on the actions which had been taken in the past year by the Department of Education in response to the fifteen recommendations.

Conclusion

There is little disagreement that the educational technologies discussed in this paper contain great promise for the schools - particularly the small/rural school poor in financial and staff resources. There is likewise little disagreement over the contention that none of these technologies has come close to realizing its promise to date. We identify two levels of action necessary to enhance the infusion of technology into the schools: those to be taken on the part of the individual school district, and those required of the State Education Department.

Meister and Levin (1986)⁶¹ contend that it is the paucity of high quality software which has hindered the realization of the promise offered by educational technology. They identify obstacles in the marketplace which inhibit firms from undertaking large-scale, long-term software development projects, the most formidable of which is the lack of a nationwide market willing to purchase such software once developed. The authors call for joint software development between private firms and the state to insure a market for quality software once it is developed.

Willet, et al (1979)⁶² point to the reluctance of small schools and communities to risk large capital expenditures on new technologies which, by virtue of their newness, are seen as radical departures from traditional instructional methods.

The various recommendations made to the State Education Department by the Learning Technologies and Telecommunications Task Force, and the subsequent actions taken by the state during the past year reflect the above concerns and others we have identified in this paper. It is imperative that the state continue its initiatives in areas such as the development of a standard for teacher training in educational technology as a condition for certification; providing a means for upgrading the skills of existing teachers; and conducting statewide evaluations of experimental technology projects around the state and nation and disseminating the results of these evaluations to New York's school districts.

The small/rural school district should note that such broad initiatives are designed to address educational concerns of all school districts in the state. Because these actions represent a large scale approach to altering the educational design of the schools, they will not occur quickly. While it is hoped that at some future point the actions taken by the State will bear fruit for small schools, such results are unlikely to occur soon enough to meet immediate planning and implementation needs. Therefore, small districts must exercise prudence and opportunism as they scrutinize the various technologies which are available to them and seek to provide the best level of education to their students at an expense which can be borne by the district taxpayers. We have tried to offer suggestions and information which will assist the local districts while they await action from the state level which will further assist their efforts to integrate educational technology into their learning programs.

Notes

1. Regents Advisory Council on Learning Technology, (1986), Learning technologies and telecommunications in New York State: A status report on Education Department activities relative to the action recommendations approved by the Board of Regents on May 24, 1985, p. 3.
2. Ibid. Pg. 2
3. See for example, Brand, S. (1985) Biting the Hand that Feeds. Whole Earth Review, 44:5; Cyert, R.M. (1984) The Impact of Microcomputers on Education, in The Computer Culture, Evans, S. & Clarke, P. (eds.), Indianapolis: White River Press, Inc.; and Norris, W. (1985), Improving education through technological innovation. T.H.E. Journal June, 1985 pp. 65-68.
4. Various writers have considered this theme. See, for example: Willet, et al. (1979) Modernizing the Little Red Schoolhouse, New Jersey: Educational Technology Publications; Levin and Meister, (1984) Computers in the balance: weighing costs and effectiveness. Stanford, CA: Policy Perspectives for the Institute for Research on Educational Finance and Governance; and Jamison (1978) The costs of educational media: guidelines for planning and evaluation. Beverly Hills, CA: SAGE Publications.
5. From The Use of A Computer to Help Teach the School Curriculum. (1983), Minnesota Association for Supervision and Curriculum Development.
6. Center for Social Organization of Schools. (1983). School uses of microcomputers, Nos. 1-5. Baltimore, MD: The Johns Hopkins University.
7. Papert, S. (1980) Mindstorms: children, computers and powerful ideas. New York: Basic Books.
8. A great deal of empirical research has been conducted on the claim of whether programming improves cognition. For two views on this issue see Clements and Gullo (1984), Effects of computer programming on young children's cognition. Journal of Educational Psychology, 76(6): 1051-1058; and Linn (1985) The cognitive consequences of programming instruction in classrooms. Educational Researcher, May :14-16+.
9. For a good introduction to the swirling debate around the quality of educational software, see Self, J. (1985) Microcomputers in education: a critical evaluation of educational software. Sussex: Harvester Press, Ltd.
10. See Robinson, S. (1982) Questions for teachers: micromachines raise macroissues of power and principle in education. Today's Education, 71:29-30; and Wallace, J. & Rose, R. (1984). A hard look at software: what to examine and evaluate. Education Technology, 24:35.
11. Gula, R. (1984) Beyond the typewriter: an English teacher looks at the word processor. In Improving Instruction with Microcomputers, Tashner, J. (ed.) Phoenix, AZ: Oryx Press.

12. Ware, I. (1983) Technology and Education. Handbook prepared by Constituent Associations forming the New York State Council of Educational Associations.
13. Ramer, B. (1985) Computers - will they survive? New York State School Board Association Journal, February edition, pp. 23.
14. These summary questions come from Eggers and Wedman, (1985) The growing obsolescence of computers in education. Educational Technology, 25:27-29. They go on to suggest that: "Schools committed to acquiring more and more computers might be advised to earmark some computer dollars for use in providing inservice training for teachers. Teachers are watching school administrators and decision makers to see how committed they are to computer technology. Computer inservice training, funded by the school, would be taken as a real indication of such support and commitment." (pg 27)
15. Lepper, M.R. (1985) Microcomputers in education. American Psychologist, 40(1):1-18.
16. Kulik, J.A., Kulik, C.C. & Cohen, P.A. (1980) Effectiveness of computer-based college teaching: a meta-analysis of findings. Review of Educational Research, 50(4):524-544.
17. Shane, H.G. (1982) The silicon age and education. Phi Delta Kappan, 63(5):303+.
18. Atkinson, R.C. (1976) Adaptive instructional systems: some attempts to optimize the learning process. In D. Klahr (Ed.) Cognition and Instruction, New York: Wiley.
19. Tennyson, R.D. (1981) Use of adaptive information for advisement in learning concepts and rules using computer-assisted instruction. American Educational Research Journal, 18(4):425-438.
20. Papert, S. (1984) Microworlds: Transforming Education. Ch. 5 in Evans, S.H., Clarke, P. (eds.) The Computer Culture, Indianapolis, White River Press, Inc.; Papert (1980) and Clements & Gullo (1984), op cit.
21. Jamison, D. (1978) The Costs of Educational Media: Guidelines for Planning and Evaluation. SAGE Publications, Beverly Hills, CA.
22. Levin, H.M. & Woo, L. (1981) An evaluation of the costs of computer-assisted instruction. Economics of Education Review, 1(1):1-25.
23. Vinsonhaler, J.F. Bass, R.K. (1972) A summary of ten major studies on CAI drill and practice. Educational Technology, 12, 29-32.
24. Edwards, J., Norton, S., Taylor, S., Weiss, M., & Dusseldorp, R. (1975) How effective is CAI? A review of the research. Educational Leadership, 33, 147-153.

25. Jamison, D., Suppes, P. & Wells, S. (1974) The effectiveness of alternative instructional media: a survey. *Review of Educational Research*, 44(1): 1-67.
26. Hartley, S.S. (1977) Meta-analysis of the effects of individually paced instruction in mathematics. Doctoral dissertation, University of Colorado, Dissertation Abstracts International v38(07):4003.
27. Kulik, Kulik and Cohen, (1980). Op cit.
28. Kulik, J.A., Cohen, P.A. & Ebeling, B.J. (1980) Effectiveness of programmed instruction in higher education: a meta-analysis of findings. *Education Evaluation and Policy Analysis*, 2: 51-64
29. Kulik, J.A. (1981) Integrating findings from different levels of instruction. Paper presented at the American Educational Research Association, Los Angeles, April, 1981. (ERIC Document number ED 208 040)
30. Kulik, J.A., Bangert, R.L. & Williams, G.W. (1983) Effects of computer-based teaching on secondary school students. *Journal of Educational Psychology*, 75, 19-26.
31. Burns, P.K. & Bozeman, W.C. (1981) Computer-assisted instruction and mathematics achievement: Is there a relationship? *Educational Technology*, 21:32-39.
32. Hawkins, J.; Sheingold, K.; Gearhart, M.; & Berger, C. (1982) Microcomputers in schools: impact on the social life of elementary classrooms. *Journal of Applied Developmental Psychology*, 3(4):361-373.
33. Condry, J. & Keith, D. (1983) Educational and recreational uses of computer technology. *Youth and Society*, 15(1):87-112.
34. Mevarich, Z.R. & Rich, Y. (1985) Effects of computer-assisted mathematics instruction on disadvantaged pupils' cognitive and affective development. *Journal of Educational Research*, 79(1): 5-11.
35. The ETS evaluation of writing to read, (1984) Executive Summary, Princeton, NJ: Educational Testing Service.
36. Clark, R.E. (1985) Confounding in educational computing research. *Journal of Educational Computing Research*, 1(2):137-148.
37. For example, see Meyer, R. (1984) Borrow this new military technology, and help win the war for kids' minds. *The American School Board Journal*, June, Pg. ____; and Bosco, J.J. (1984) Interactive video: educational tool or toy? *Educational Technology*, 24(4): ____
38. Information on the workings and the history of IVD was derived from Gay, G. (1985) Interaction of learner control and prior conceptual understanding in computer-assisted video instruction. Paper presented at AERA annual meeting, Chicago, Ill.; Johanssen, D.H. (1984) The generic disc: realizing

the potential of adaptive, interactive videodiscs. Educational Technology, 24(1): ____; and Laurillard, D.M. (1984) Interactive video and the control of learning. Educational Technology, 24(1): ____

39. Johanssen, D.H. (1984) op cit.

40. Halligan, W.J. (1986) Telecommunications opportunities for rural education. NYSSBA Journal, March: pgs. 14-15.

41. Levinson, C. Y. (1985) Tuning in long-distance classes. New York Times Education Summer Survey, 8/18/85, p. 14.

42. Willett, E.J.; Swanson, A.D.; & Nelson, E.A. (1979) Modernizing the Little Red Schoolhouse. Educational Technology Publications: New Jersey.

43. Loughary, J.W. et al. (1966) Man-Machine Systems in Education. New York: Harper & Row.

44. Willett, E.J.; et al (1979) Op. cit. Pg. 187.

45. Ibid. Pg. 186.

46. Ibid. Pg. 17.

47. Information derived in part from the State Education Department's Center for Learning Technology.

48. Phone conversation with Ithaca College Teacher Jane Vogel, 6/26/86, and 9/9/85 Ithaca Journal article entitled TV english teacher challenges advanced students by Nina Nirenberg.

49. Regents Advisory Council on Learning Technology, (1986), Op. cit. Pgs. 1-2.

50. Benson, G.M. et al. (1985) Telecommunications in New York State: Background and Educational Capacities. Report to New York State Education Department.

51. Illinois' link to the cosmos. (1986) Electronic Education, 5(7):8-9.

52. Ibid. Pg. 9.

53. Albertson, L. (1986) This is outerspace calling. Electronic Education, 5(7):7+.

54. Levinson, C. Y. (1985) Op. cit.

55. Jamison, D.T. (1978) The Costs of Educational Media: Guidelines for Planning and Evaluation. SAGE Publications, Beverly Hills, CA.

56. Bosco, J.J. (1984) Op. cit.

57. Jamison, D.T. (1978) Op. cit.

58. State Education Department Learning Technologies and Telecommunications Task Force (1985) Learning technologies and telecommunications in New York State: action recommendations. Approved by the Board of Regents on May 24, 1985. Page 2.

59. Benson, G.M. et al. (1985) Telecommunications in New York State: Background and Educational Capacities. Report to New York State Education Department. Pg. 11.

60. Regents advisory council on learning technologies (1986). Policy recommendations to the N.Y.S. education department. (Formal recommendations were made to the Department on May 2, 1986.

61. Meister, G. & Levin, H.M. (1986) Educational technology: promises, promises, promises. Report for the Institute on Educational Finance and Governance. School of Education, Stanford University.

62. Willett, E.J. et al (1979) Op. cit.